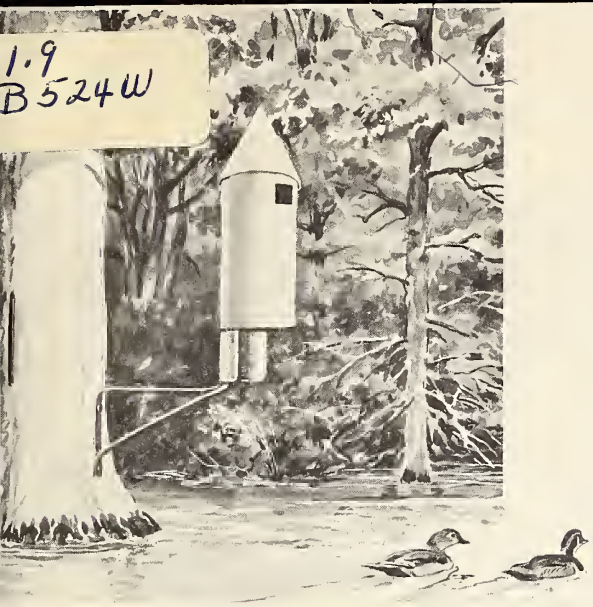

IMPROVED NEST STRUCTURES FOR WOOD DUCKS

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Most wild ducks nest on the ground, but the wood duck, or summer duck, normally nests in tree cavities. This helps explain why the number of wood ducks dropped severely during the past century, when removal of unsound trees and heavy cutting of mature timber destroyed many natural nesting sites. It also indicates why artificial nesting sites can be of practical value in many places.

The possibility of increasing wood duck populations by means of nest structures depends mostly on the quality of habitat in the bird's diverse breeding range (largely the eastern half of the United States and the Pacific Coast States south to central California). In many areas, suitably designed and erected nest structures have proved effective. The Illinois Natural History Survey pioneered in work with improved nest structures, and the Massachusetts Division of Fisheries and Game also has done considerable research and has erected thousands of structures. Other States, private groups, and individuals have helped to restore wood duck numbers by providing artificial nesting sites.

Success with wood duck nest structures is complicated by the fact that they are attractive to various kinds of wildlife, some welcome and others not. Desirable, or largely unobjectionable, species that nest in the structures include goldeneyes, hooded mergansers, screech owls, sparrow hawks, flickers, bluebirds, tree swallows, and great crested flycatchers. Competition of these species with wood ducks is generally slight and usually can be eliminated by erecting more structures.

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Other occupants or visitors can be objectionable, however. In many areas raccoons are by far the most important predators. They consume many eggs, and occasionally kill incubating ducks. Raccoons may not visit vulnerable nest structures the first year or two after they are put up, but sooner or later one of them discovers a nest with eggs. Thereafter, it is likely to seek eggs in each structure it finds. Wood duck eggs have also been destroyed by fox squirrels, bull snakes, rat snakes, and mink. The mink may occasionally prey on incubating ducks. Various species of small birds, white-footed mice, and several species of tree squirrels may fill the structures with their nests and thus prevent the ducks from using them. In many areas starlings are the worse competitors for nest structures, and quite often one will build its bulky nest directly over a clutch of wood duck eggs. Occasionally, structures serve as dens for raccoons and opossums or nest sites for bees and wasps.

IMPROVED DESIGNS

Under certain circumstances nest structures may be liabilities to wood ducks rather than assets. When the structures merely make wood duck eggs more available to predators or encourage use by undesirable competitors, erecting them does more harm than good. Many persons have been discouraged with the results of their nest-structure program, and have felt that their time and money were wasted. For these reasons, much effort has been directed toward developing improved designs where needed.

Early attempts were concentrated on erecting guards of various sorts around mounting posts or trees. Guards, however, have not always proved satisfactory, either because of the faulty design or because of difficulty of obtaining a tight fit and of keeping them secure and in proper position. Erecting structures over water or on metal posts without guards, or hanging them on wire stretched between two trees also proved to be no guarantee that raccoons would not reach the structures and enter them. Later attempts at raccoon proofing consisted in developing adaptations on the conventional wooden structures, such as an oval opening or a tunnel entrance. These adaptations have served the purpose effectively in some regions, but have not been uniformly successful in keeping out raccoons in all parts of the country.

Current tests have shown that certain other types of guards or methods of mounting the nest structures are more universally effective. Also a recently designed nest structure shows promise of reducing competition from starlings.

PREDATOR GUARDS

Different mounting devices--metal posts, wooden posts, or large trees--require different predator guards.

A metal post can be equipped with a simple yet effective guard by enclosing the post "sandwich fashion" between two halves of a folded piece of No. 24 gauge (0.020 inch thick) moderately soft sheet aluminum. This

guard should be folded tightly and smoothly to form a 2-walled thin-edged panel 38 inches high and 9 inches wide (fig. 1). The free edges of the double wall are fastened together lengthwise with five No. 10 brass machine screws $\frac{1}{4}$-inch long, or with brass or copper rivets, placed at intervals of 8 inches, beginning at the middle. The guard is securely attached by means of a bolt or piece of wire that passes through the top of the guard and the post.

If a wooden mounting post is used, it can be equipped with a large, cone-shaped, sheet-metal guard (figs. 2 and 3) that is secured to the post with wooden mounting blocks and galvanized nails. The guard should fit the post tight enough to keep snakes from squeezing through. The cost of the guard per structure can be reduced by mounting two structures on one pole, or as many as six structures on crossbars between paired poles, as has been done in Vermont (fig. 2). It is recommended that no more than six structures be erected in one group, since a greater number may cause the birds to become confused and to abandon their nests. According to biologist William R. Miller, these guards have protected wood ducks in Vermont not only from raccoons but also from mink that destroyed nests in unprotected structures nearby.

A 50-gallon metal drum can be used as an equally effective guard on a wooden post if there are no holes in the side of the drum. A hole of the same diameter as the post can be cut in each end of the drum and the drum then slid down over the post. The drum should be supported a little above water by two pieces of 2- by 4-inch lumber nailed to the post. These supports should not protrude beyond the edge of the drum. Conspicuousness of the drum is reduced by mounting two nest structures on top of it on opposite sides of the post.

Isolated trees up to about 6 inches in trunk diameter can be equipped with the cone-shaped guard. This guard may not be effective on larger trees because the width of the overhang may be reduced too much to be effective unless the diameter of the guards is made larger. To increase the size of the guard would raise the cost considerably. These larger trees can be guarded with a band of sheetmetal, about 3 feet high, which completely encircles the trunk. It can be attached with a nail and flat washer at each of the two exposed corners. The band should be loose enough to allow for growth of the tree. On trees less than a foot in diameter, the sheetmetal "wrap-around" should be a few inches larger in diameter at the top than at the bottom so that the taper will be enough to prevent a raccoon from climbing the guard by hugging it with its paws. The top edge should be bent in to prevent debris from catching in the guard. The lower edge should be moderately crimped in the form of corrugations so it will fit the trunk tightly and exclude snakes, yet expand with the trunk as the tree grows.

On a tree that is well located for nest structure installation but not suitable for a sheetmetal guard because the trunk is large or irregular, a special nest structure and bracket combination can be used. This and other nest-structure and predator-guard combinations suited to special situations will be described later.

NEST STRUCTURES

Nest structures can be made of wood or metal. Many people prefer wood because they consider wooden structures easier and cheaper to build than metal ones. This may be true for structures built from old nail kegs or ammunition boxes, but the useful life of these boxes is so short that they seldom justify the time required to adapt and erect them. However, installation of such inexpensive, short-lived structures may be practical for testing wood duck acceptance of artificial structures in areas where box use has been low, as, for example, in many southeastern States; they may be practical also when labor or materials are available at little or no cost.

In some places wooden structures may be preferable to metal because they do not become so hot, though tests show that wood ducks readily utilize metal structures and successfully bring off young from them. Higher temperatures in midsummer after the principal breeding season may be more critical to wood ducks nesting then, but no evidence has been found that heating of metal structures has caused nesting to be unsuccessful. It is suggested that, where possible, metal structures be placed in sites that are at least partly shaded.

Wooden nest structures.--Easily built wooden nest structures are shown in figures 4 and 5. The structures should measure, inside, 8 to 10 inches wide, 10 inches from front to back, and at least 20 inches high. The entrance should be within 2 inches of the top to provide the subdued light and seclusion that the wood duck appears to seek. If the structure is on a post or tree equipped with a satisfactory guard, either a round entrance hole 4 inches in diameter or a rectangular hole $3\frac{1}{4}$ inches high and 4 inches wide is quite satisfactory. In the more northern States, special entrance guards alone have been successful in excluding all but an occasional raccoon that was smaller than most.

In Illinois, Frank Bellrose (1955) found that an elliptical opening 3 inches high and 4 inches wide in a wooden nest structure admitted wood ducks but excluded raccoons. However, raccoons sometimes gained entrance by gnawing the hole larger. This difficulty was largely corrected by masking the opening with a piece of galvanized sheetmetal about 6 inches across with a 3- by 4-inch elliptical hole in the center (fig. 4).

Another method of preventing raccoons from entering wooden nest structures was developed in Massachusetts (McLaughlin and Grice, 1952). Structures were equipped with wooden entrance tunnels that were 4 by 4 inches on the inside and 10 inches long (figs. 4 and 5). This type of entrance guard effectively excluded raccoons in Massachusetts during 11 or more years of use on several hundred structures. Wooden tunnels 3 inches high and cylindrical metal tunnels that would effectively deter raccoons also were tried in Massachusetts, but both reduced use of the structures by ducks. Results of an experiment conducted in Rhode Island (Cronan, 1957) seemed to indicate that when hen wood ducks had a choice they nested in structures without wooden-tunnel guards. However, when all the structures in a given area had tunnel guards, or when nesting pressure was high, the guards did not appear to reduce use of structures.

In Maryland, both tunnels and oval entrances have failed to prevent raccoons from destroying many wood duck nests. There is some evidence that raccoons in Maryland are smaller than those in Massachusetts and Illinois. Results of an experiment indicated that raccoons weighing about 9 pounds or less could pass through a 4- by 4-inch tunnel or a 3- by 4-inch elliptical hole. Along with many other warm-blooded animals, raccoons tend to be smaller in warmer climates, and in our sourthern States a large percentage of them may be able to pass through entrance guards.

The following suggestions will help in construction of wooden structures:

(1) Use 1-inch boards of well-seasoned wood, either dressed or rough-sawed. Pine is satisfactory, but is not as long lasting as cypress.

(2) Use nails that are long enough to hold securely despite rough handling and weathering; 8-penny or 10-penny nails are satisfactory. Coated box nails will last 5 or 6 years. Use galvanized nails if the box is made of cypress or is treated with a preservative. Fasten a loop of No. 12 galvanized steel wire tight around the structure for additional strength.

(3) Bore four $\frac{1}{4}$-inch drainage holes through the bottom of the structure.

(4) If the inside surface of the front board is smooth, as it will be if dressed lumber is used, tack a strip of fine hardware cloth about 3 inches wide from the bottom of the structure to the entrance hole. This will help ducklings climb out of the nest.

(5) Treat pine and other less durable woods with a preservative. A relatively clear preparation such as one containing pentachlorophenol or other preservative non-injurious to the ducks, is satisfactory for all surfaces; a creosote type of preservative is suitable only for the bottom. (Labels on trade-name preparations should list the active ingredients and their effects.) It is especially important to treat the areas of the box that generally rot the quickest. These include the bottom, the part of the back that will be next to the post, and the inside area that will be covered with nesting material. Treated structures should be dried for several weeks before they are made available to nesting ducks.

(6) Do not use creosote or any other dark coating on the roof or out-side walls. It was formerly believed that old, weather-stained structures were more attractive to wood ducks, but most recent evidence shows that conspicuous, new structures are more readily used, probably because they are more easily seen. An additional advantage is that a light-colored structure absorbs less heat from the sun.

<u>Vertical metal nest structures</u>.--To exclude fox squirrels from nest structures mounted on trees, the Illinois Natural History Survey developed a cylindrical, sheetmetal structure with a steep, conical lid (Bellrose,

1955). When this structure is properly constructed and mounted against a tree trunk away from limbs, squirrels can rarely reach the entrance, either from the side or over the steep roof. Raccoons, however, have been able to reach the peak of the roof, grasp it with their feet and lower themselves headfirst to the entrance (fig. 11). Where the 3- by 4-inch oval entrance is unsuccessful, as in Maryland, or where a larger hole is wanted in order to permit easy passage of wood ducks or goldeneyes, the metal structure alone is not raccoon-proof.

The metal structure (figs. 6 and 7) consists of a cylindrical body 11 or 12 inches in diameter and 24 inches high and a steep, cone-shaped roof. Either 26-gauge galvanized sheetmetal or 12-inch diameter galvanized furnace pipe may be used for the cylinder, and the bottom may be made of wood. A 3- by 8-foot metal sheet will provide four 2- by 3-foot pieces for making four cylinders approximately 11 inches in diameter.

Boxes of galvanized metal quickly become dull and when exposed to the sun absorb considerably more heat than wooden ones. This can be corrected by painting them aluminum, which also increases their durability. In order to apply certain aluminum paints over galvanized metal, a zinc chromate undercoat is required. Limited tests indicate that the bright aluminum paint does not deter wood ducks from nesting, but that it may scare migrating ducks of various species. If birds are frightened, it is best to use gray or a light shade of brown or green paint of a type that is made to adhere to galvanized metal.

Two methods have been devised for erecting vertical metal structures so that the structure itself is part of the predator deterrent (figs. 6 through 8). One method is for mounting structures on metal posts and the other is for mounting them on trees. Neither of these two methods requires the use of a separate guard on post or tree.

When the structure is to be mounted on a metal post, it should be bolted snugly to a steel "U" (channel) post as shown in figures 6 and 8. It is important that there be no gaps to provide claw holds where the edges of the post touch the nest structure. For the same reason, all extruded fasteners on the post must be hammered back into place with a sledge so that all openings are closed (fig. 6). The post should be painted as often as required to prevent rust, which could produce a rough surface and enable a raccoon to climb to the top. No backing board should be used between the structure and post since a raccoon can climb it to the top of the structure (fig. 11).

The structure should be about 3 feet tall to prevent large raccoons from reaching the entrance. If a structure 2 feet tall is used, it should be provided with a sheetmetal "shirttail" that is 6 inches wide and extends downward 12 inches from just inside the structure (figs. 6 through 8). This "shirttail" should be bolted firmly to the post. When the structure is properly constructed and mounted, a raccoon can easily climb upward to it but can go no farther. When 2-foot high structures without "shirttails" were used in Maryland, an occasional raccoon learned how to gain entrance. By clinging to the post with its hind feet just below the structure while

hugging the structure with its front legs for stability the raccoon was able to reach up and around to the entrance hole. The added foot of sheet metal guard on the post keeps the entrance out of reach. Since squirrels and mink, too, are unable to reach the roof of a structure mounted away from trees in this manner, a cone-shaped lid is not required. A flat, piepan type of lid is adequate and is easier to make (fig. 6).

If the structure is mounted on a tree that is not suitable for a sheet metal guard, a special mounting bracket can be used (figs. 6 and 7). Again, either a 3-foot-tall structure or a 2-foot-tall one with "shirttail" is required. The "shirttail" should extend downward from just inside the base of the structure, between the bracket and the rear wall. This type of bracket mount has proved satisfactory in Maryland. Wood ducks readily used structures protected in this way and brought off broods, even though nearby nests in structures with guards at the entrance holes were destroyed by raccoons. If the box is to be mounted on a leaning tree, it should not be placed on the lower side of the trunk.

If the nest structure is protected by an effective, independent predator guard on post or tree or is properly mounted on a "U" post or bracket, the shape of the entrance hole can be either round or rectangular (figs. 2, 3, 6, and 9).

The lid of the nest box can be attached by either of two methods. One method is to form mating catches in the lid and on the top edge of the cylinder, as shown in figure 10. A pair of these locking arrangements on opposite sides attaches the roof securely and yet permits easy removal. To hold the lid firmly such catches should be large and well formed, but they should not provide openings in which raccoons can obtain a toe hold. In the second method of attaching the lid, a metal screw is fastened permanently in the lid (fig. 10) and hooks into a slightly oversized hole in the upper edge of the cylinder. Opposite this, a piece of No. 9 wire, shaped like a hook, is inserted into matching holes in lid and cylinder. The inside of the wire hook should be long enough to keep it hanging downward but not long enough to obstruct the entrance if it should happen to swing into that position. The outside leg should be shorter and the end bent out to make it easy to insert and remove.

A ladder of hardware cloth from the bottom to the entrance, as used in the board box, will permit the ducklings to climb out. The hardware cloth should be soldered to the inside surface at each corner and midway down on each side. If ragged edges are bent under before soldering, they will be less injurious to both man and duck. Residues of soldering acid should be washed off after the ladder is attached. Automobile undercoating will provide a satisfactory grippingsurface if properly applied. Bellrose (1955) suggested mixing vermiculite (a mica material used for building insulation) with the undercoating to produce a stiff, doughlike mixture. Sawdust, if relatively free of dust, can be used instead of vermiculite. The undercoating should be applied $\frac{1}{4}$ to $\frac{1}{2}$ inch thick in a band at least 4 inches wide. Permanent toenail holds can be made for the ducklings by scoring numerous, narrow, horizontal grooves in the undercoating with a trowel. When making the grooves, the trowel should be held with the point

slanting downward at a slight angle. The bottom of the nesting structure should be provided with four $\frac{1}{4}$-inch drainage holes, and if it is made of wood, it should be treated with a preservative. The floor can be protected from water runoff by allowing the metal walls to extend $\frac{1}{2}$ inch beyond the bottom board.

Satisfactory nest structures can be made from 100-pound grease drums, which generally can be obtained from garages or gas stations. All remaining grease should be removed with a solvent or a jet of steam. The entrance can be cut with an acetylene torch or with a hammer and cold chisel. Rough edges should be bent over. Undercoating or a wire ladder should be provided so ducklings can climb out.

Horizontal metal nest structures.--Tests are now under way to design structures that will deter starlings. Encouraging results have been obtained with horizontal nest structures that admit a greater amount of light than do the vertical structures. Control of light is achieved by constructing openings at both ends of the nest structure, and making provision at one end for regulation of the amount of light that enters (fig. 1). Our studies indicate that most wood ducks are more tolerant of light than are starlings. In 1962, one-third of the 42 horizontal nest structures on the Patuxent Research Center were utilized successfully by wood ducks and none was occupied by starlings. Continued testing is necessary, however, before this method can be recommended with full confidence.

This horizontal nest structure consists of a 24-inch section of 12-inch diameter galvanized furnace pipe (fig. 1). The lower two-thirds of one end is closed with a wooden panel 1 to $1\frac{1}{2}$ inches thick; cypress is preferable, but any easily cut wood can be used if coated with a good grade of outdoor paint. A ladder of hardware cloth or metal lath should be tacked on the inside surface of this panel from the bottom to the upper edge to permit the ducklings to climb out. A wooden disk containing an opening $4\frac{1}{4}$ inches wide and $3\frac{1}{2}$ inches high near its upper edge is installed in the other end. A tab of sheet aluminum about 5 inches in diameter is fastened tightly with a single screw just below the opening so as to permit it to pivot and cover the entire hole or allow any degree of opening. Studies to date indicate that for best results more than three-fourths of the small opening should be covered by the movable tab (fig. 1).

LOCATING AND ERECTING NEST STRUCTURES

In order to attract wood ducks, structures not only should be properly built but should be suitably placed. Wood ducks favor swampy habitat; hence nest structures should never be located far from water or trees. Good visibility is especially important in attracting ducks. Structures over water receive more use by nesting ducks than those at a distance from the water. They should be placed so that the entrance will be conspicuous to birds using the water area. The front of the structure should never be obstructed by nearby vegetation. Trees or stout snags surrounded by water during the nesting season are good sites for nest structures. Such trees, when used, should be equipped with predator guards. Shoreline trees are satisfactory also, but if they are accessible to squirrels, metal structures with conical lids should be used.

In parts of Illinois, wood ducks have nested in structures as far as $\frac{1}{2}$ mile from water. Because of spring floods, structures could not be erected in the river bottoms. Instead, they were located in relatively open, mature upland hardwoods, on trees at least 1 foot in diameter. In general, however, it was found advisable to erect structures no farther than $\frac{1}{4}$ mile from water.

At the edge of the plains, wood ducks occur along wooded streams. Nesting structures here should be placed along stream banks above spring flood levels or in ponds within easy range of streams. Nest structures erected in ponds in open country far from woody cover have little likelihood of attracting wood ducks.

When placed over water, structures should be high enough so that they will not be flooded. Two or 3 feet above high water is acceptable to wood ducks and also permits easy inspection and maintenance of the structures from a boat. On banks or upland sites where there is a greater chance of human disturbance, structures should be 8 feet or more above ground level.

In general, it is recommended that only a few nest structures be established in an area during the first year. If wood ducks do not use them, little time or money will be lost; if the ducks accept them for nesting, and the breeding population increases, more structures can be erected as they are needed. Wood ducks are somewhat gregarious, even during the breeding season, and apparently do not object to others of their kind nesting nearby. In good wood duck habitat, it may be advantageous to erect structures in pairs or small groups.

Deep structures should be installed in a position as nearly vertical as possible or with a slight forward tilt, since a backward tilt may prevent ducklings from climbing out and may allow water to run in. For fastening structures or brackets to wooden posts or trees, 3- to 5- inch lag screws are preferable to spikes. Screws make it easier to remove structures when necessary, and permit adjustment to growth of trees to which structures are attached. A flat washer should be placed under the head of each screw used to fasten structures to wooden supports.

Wooden boxes can be attached to posts and trees with a loop of No. 12 galvanized wire. It is best to run the wire from near the top of the nest box up and around the tree or post at an angle. The ends can be twisted around a nail driven into the opposite side of the post or tree. A second loop from near the bottom of the box to the post or tree will help hold the box in place. The wire should be attached to the box in such a manner that it will not come loose or pull the structure apart. Wooden boxes are likely to be too heavy for erecting on metal posts.

The horizontal metal nest structure can be mounted as shown in figure 1. A 1/8-inch hole is drilled through the top of the nest structure about 3 inches from each end. Into these holes are inserted two pieces of 12-gauge galvanized wire, each with a 3-inch hook at the end. The other end of each wire is attached to the post to suspend the structure. A pair of 1/8-inch holes spaced about $2\frac{1}{2}$ inches apart are drilled in the center of one side of

the nest structure to permit the insertion of a loop wire to hold the side of the house tight against the post. Another piece of wire, running vertically, connects the wires from the top with the wire at the side so as to permit adjustment of the entrance to a horizontal position.

For greater stability, two posts may be used. These are placed 18 inches apart. Each has a $\frac{1}{4}$-inch hole drilled or punched 1 inch below the top and a second hole 12 inches lower. A piece of wire is looped around both ends of the nesting structure about 3 inches from each edge and passed through the holes to bind both ends tightly against the posts.

In areas where there is little chance of extremely high floods or movement of heavy ice, boxes can be fastened to steel posts or to cedar, locust, or pressure-creosoted posts sunk into marshes or pond bottoms. If the bottom is firm, steel posts about 7 or more feet long, depending upon the water depth, are satisfactory and are easier to install than wooden posts. If the bottom is moderately soft, a 2-foot crosspiece should be bolted, riveted, or welded to the post 3 to 4 feet above its base to prevent it from sinking deeper and to add to its stability. If steel posts are used on deep, soft soil, an extra length of post can be driven deep into the soil, leaving about 2 feet projecting. A second post, to which the box is attached, can then be tightly wired or bolted to the basal post. Steel posts should be galvanized or coated with paint that resists rust. They will last much longer if they are fastened above water to well-set wooden posts (Figure 8). This is especially true in acid or brackish waters, which accelerate rusting.

In soft, muddy, or mucky bottoms, as in marshes, the post can usually be driven or twisted in. To sink a wooden post into a firm bottom, it is easier to use a rotary-type posthole digger and wedge the post tightly in place with stones or stout stakes driven in around the base.

Poles have been placed successfully in New England in winter when ice is thick. First, a hole slightly larger than the pole to be erected is cut through the ice. Then a pole about 14 feet long, with one end sharpened, is placed upright in the hole and forced by hand as far into the soft bottom as possible. Several methods of forcing the pole deeper into the marsh have been devised. In the first, used by David Grice of the Massachusetts Division of Fisheries and Game, another pole is fastened horizontally to the upright one with a light log chain. Two men stand on the crossbar to add weight, and a third man, holding onto the end of the crossbar, walks in a circle until the upright has sunk to the proper depth. A second method was devised by Robert Fuller in Vermont. After the pole is set in place through the ice, a Jeep with a rear-end winch is backed into place against the pole. A cable from the winch is fastened to the top of the pole, which is then pulled straight downward into the marsh bottom by the winch and weight of the Jeep. A third method, which is practical under favorable conditions, is to stand on a tall stepladder on the ice and drive the post in deeper with a maul. Four or more feet of the pole should extend above the high-water level.

NESTING MATERIAL

Since wood ducks carry no nest material, about 5 inches of sawdust and shavings should be put in the nest structure. Used by the ducks to cover their eggs, this substitutes for the decaying wood usually found in natural tree cavities. William R. Miller reports that in Vermont starlings often remove shavings from a structure, but are not so prone to remove sawdust. Shavings should be included, however, because sawdust tends to pack.

SOME IMPORTANT CONSIDERATIONS

It bears repeating that nest structures do more harm than good when predators destroy eggs laid by ducks attracted to these structures. In one series of structures, raccoons destroyed eggs in 20 out of 24 nests and killed an incubating wood duck on 1 of the other 4.

Structures also fail to fulfill their purpose if they are not maintained properly. They should be inspected at least once a year, preferably shortly before the birds return to nest. At this time repairs can be made, debris cleaned out, sawdust and shavings loosened, and fresh material added.

It costs little more to build a good nest structure that will last 10 to 15 years than it does to build one that will last only 3 to 5 years. Durable, predator-proof structures in carefully selected sites produce more ducklings and are well worth a little extra work and expense.

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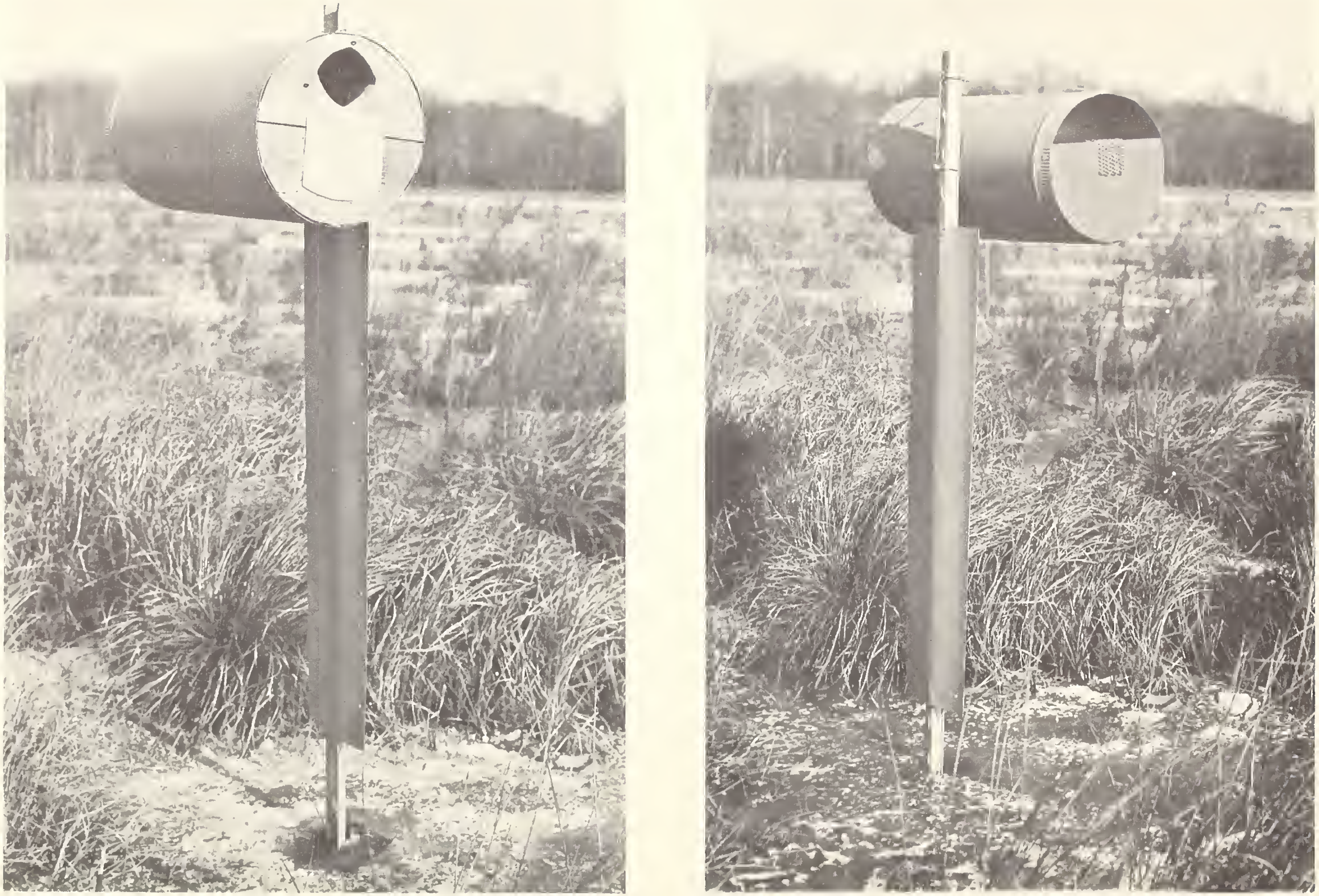

Figure 1.--New type horizontal nesting structure: Metal strip on post keeps out climbing predators. View at left shows entrance end. View at right shows back end; metal tab turned partly over hole regulates amount of light, to discourage starlings from nesting.

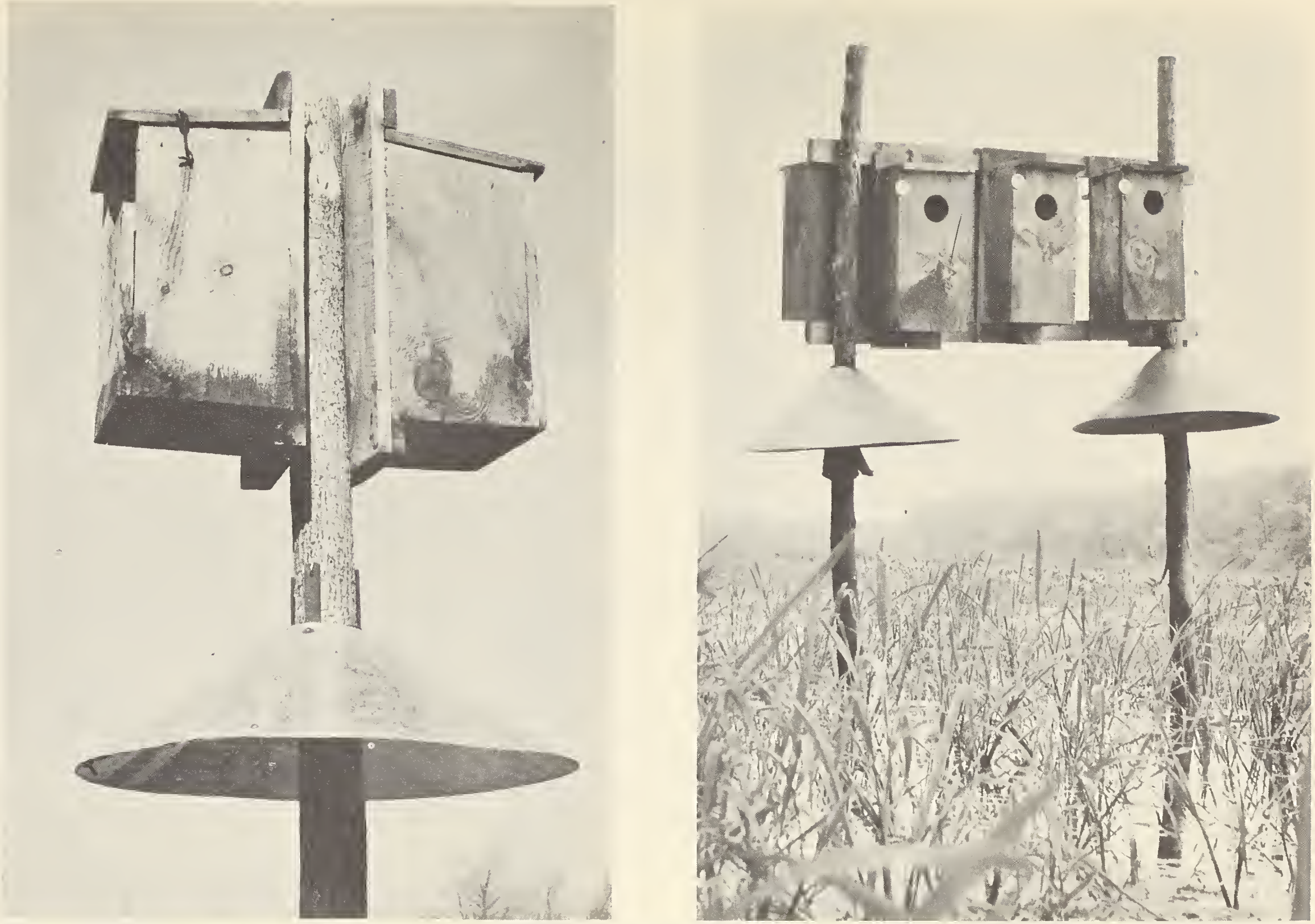

Figure 2.--Wooden boxes protected by predator-proof guards. The use of two or more boxes per shield reduces the cost of shield per box.

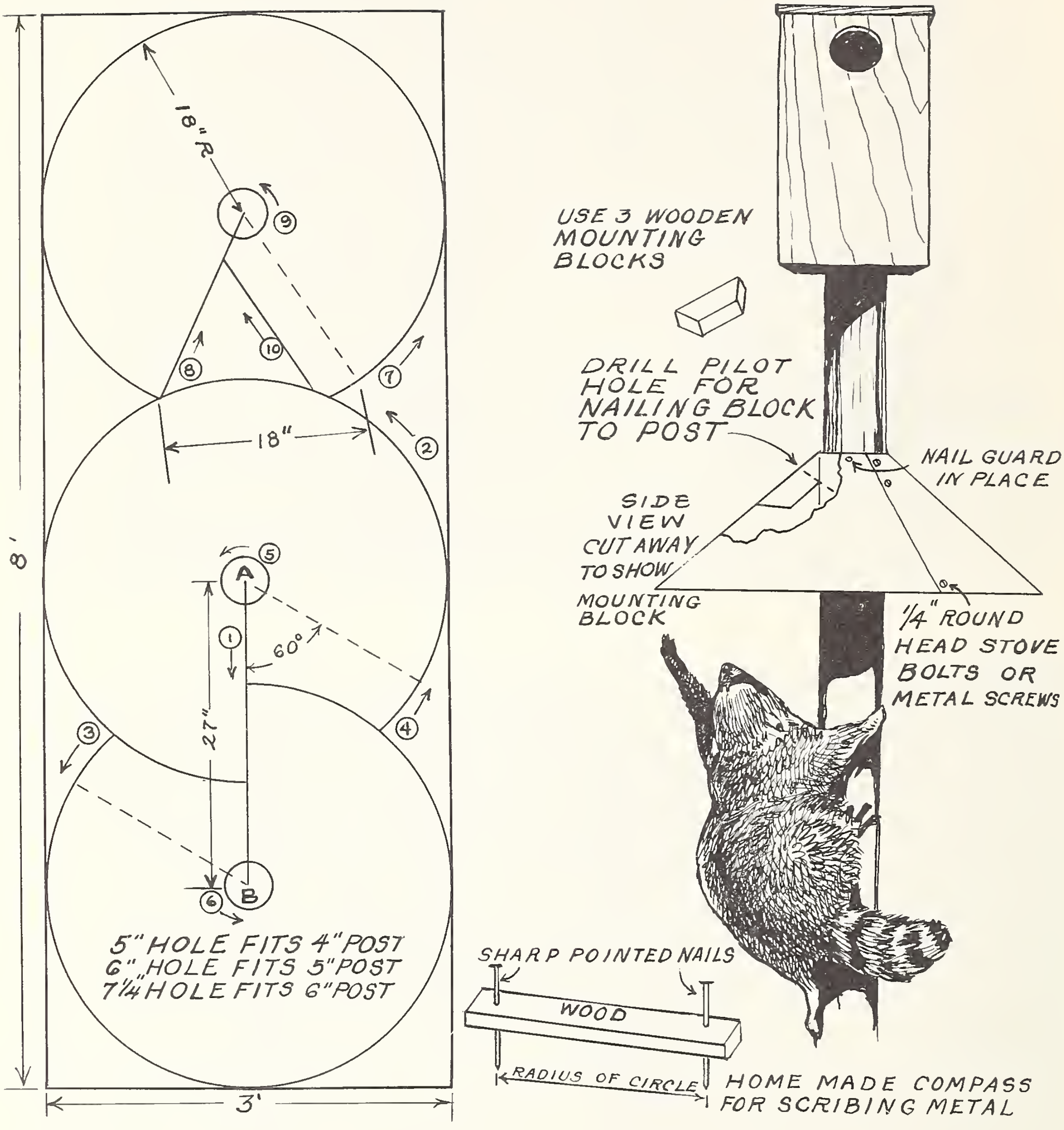

Figure 3.--Cone-shaped sheet-metal guard for protecting nest structures from predators. At left is layout for cutting three predator guards from a 3- by 8-foot sheet of 26-gauge galvanized metal. When installing the guard, overlap cut edge to dotted line. See hole sizes. To facilitate cutting (on solid lines only) follow sequence of numbers. Make circular cuts in counterclockwise direction. To make initial cut on line A-B, make slot at A with a cold chisel for inserting shears.

Figure 4.--Common types of nest box entrances. The oval entrance at left and tunnel at right have proved successful in excluding raccoons in the North but have not been uniformly satisfactory in the South. The center box is seldom raccoon-proof anywhere.

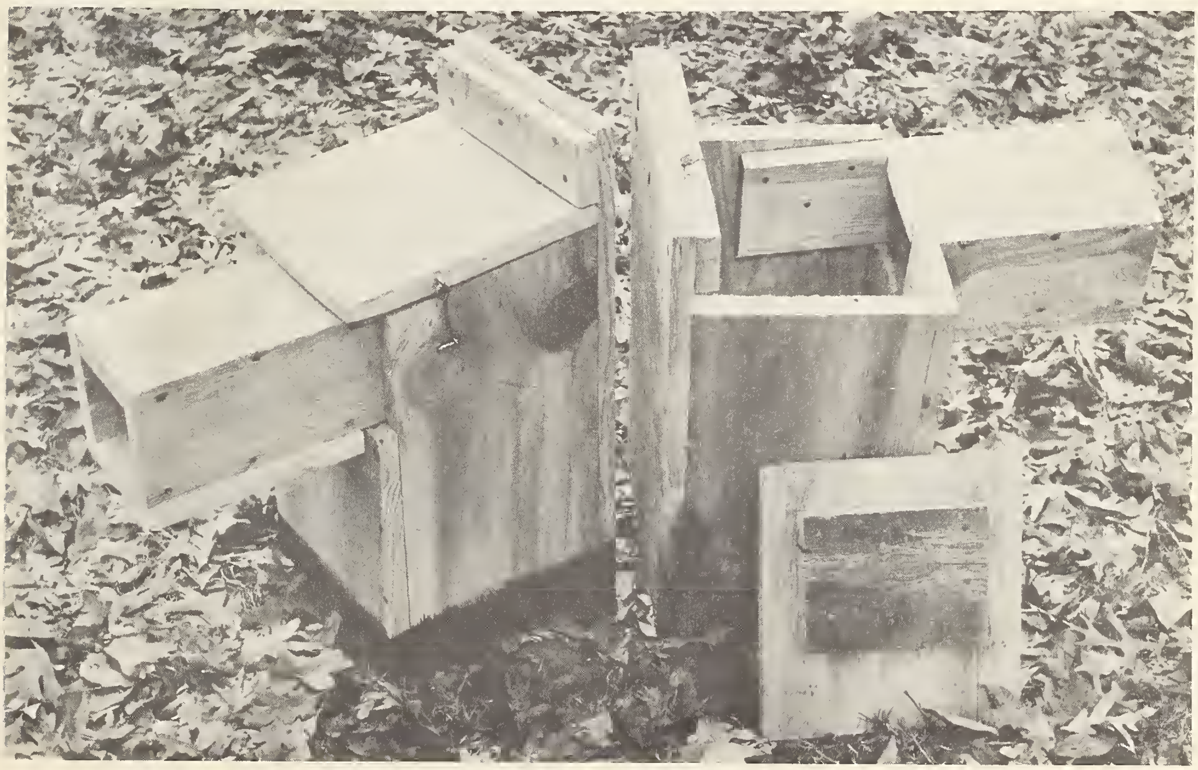

Figure 5.--Views of nest box with tunnel entrance built in.

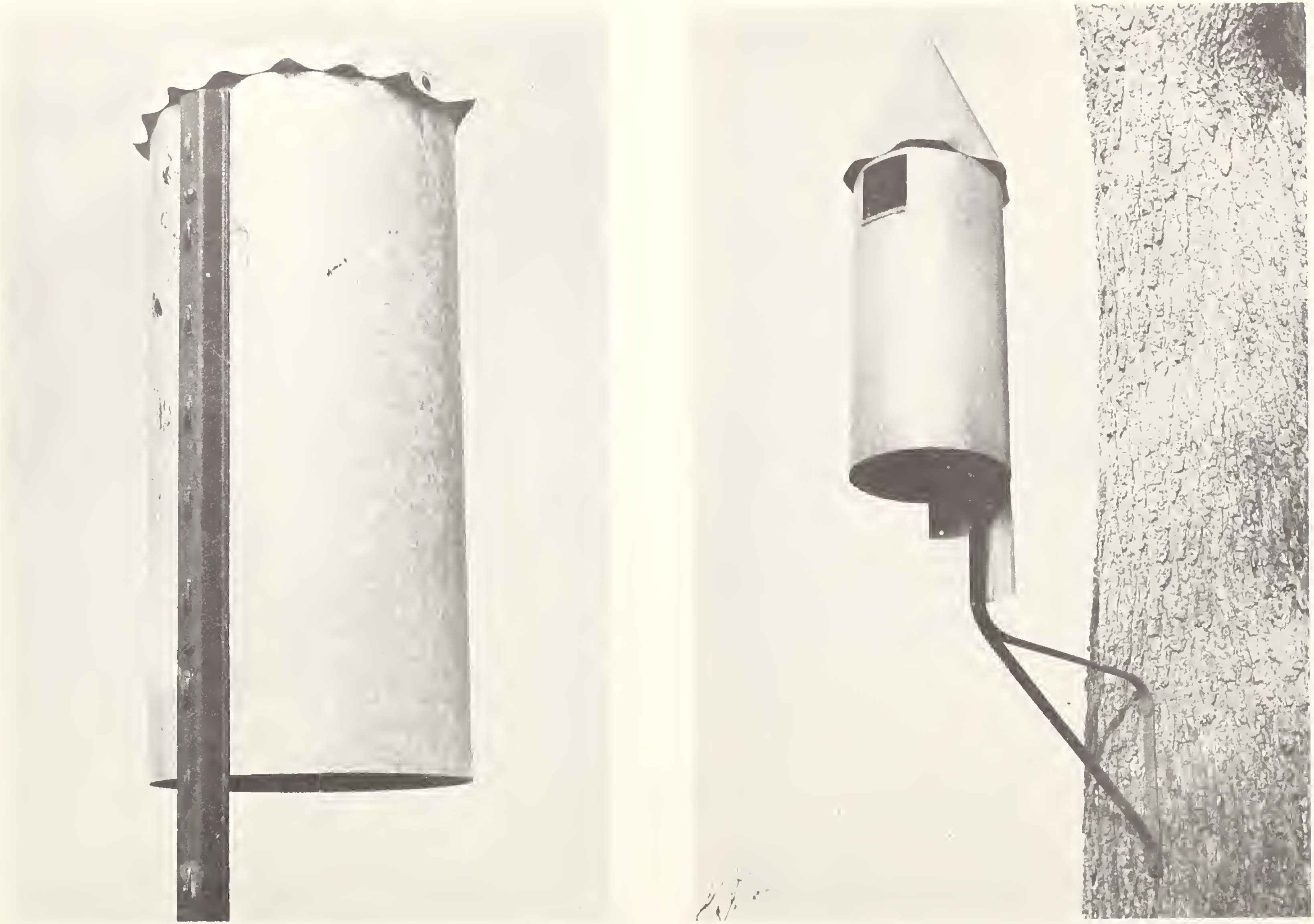

Figure 6.--Metal nest boxes can be predator-proof if they are supported in either of the two ways illustrated. Raccoons can climb to the nest box but cannot reach the entrance.

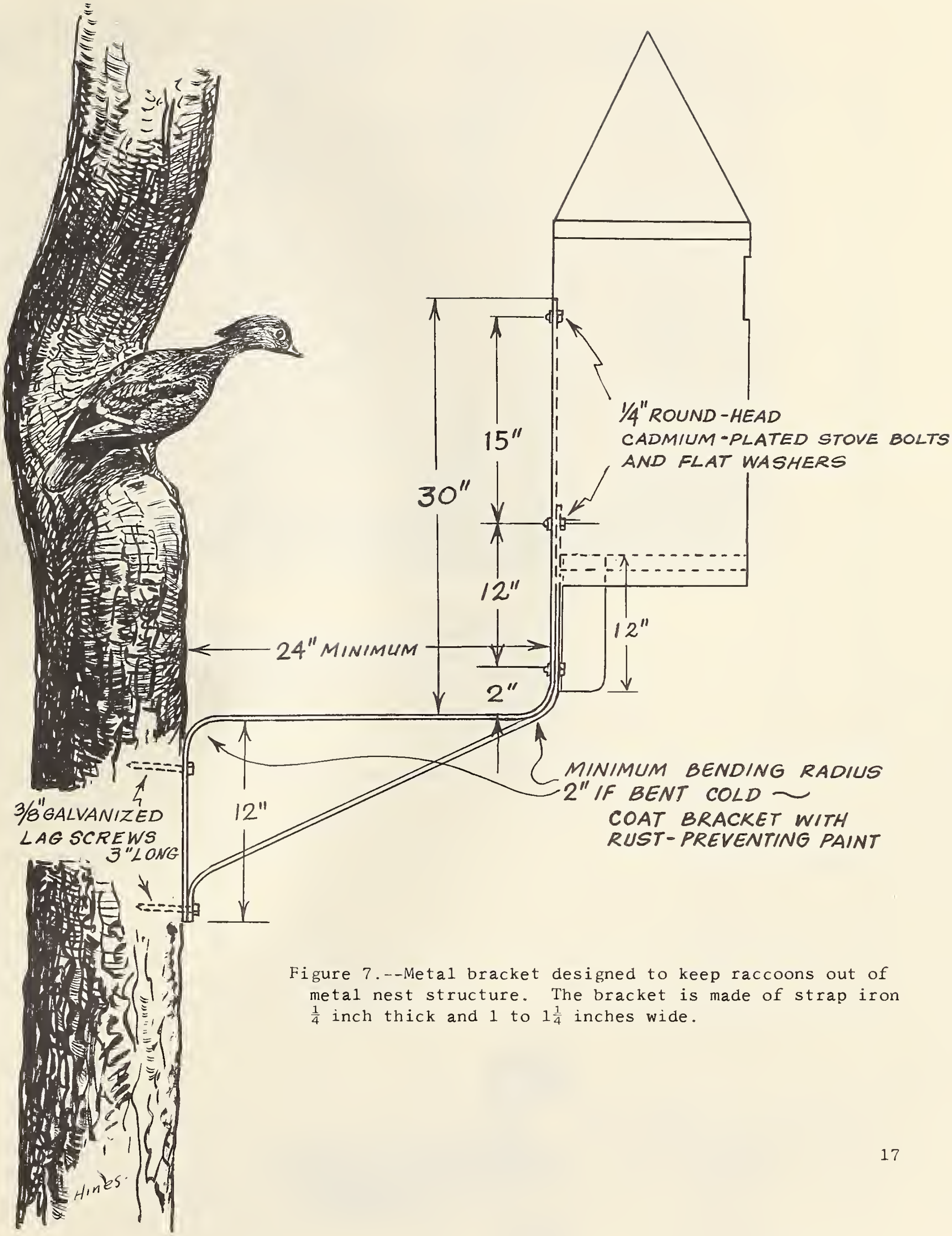

Figure 7.--Metal bracket designed to keep raccoons out of metal nest structure. The bracket is made of strap iron $\frac{1}{4}$ inch thick and 1 to $1\frac{1}{4}$ inches wide.

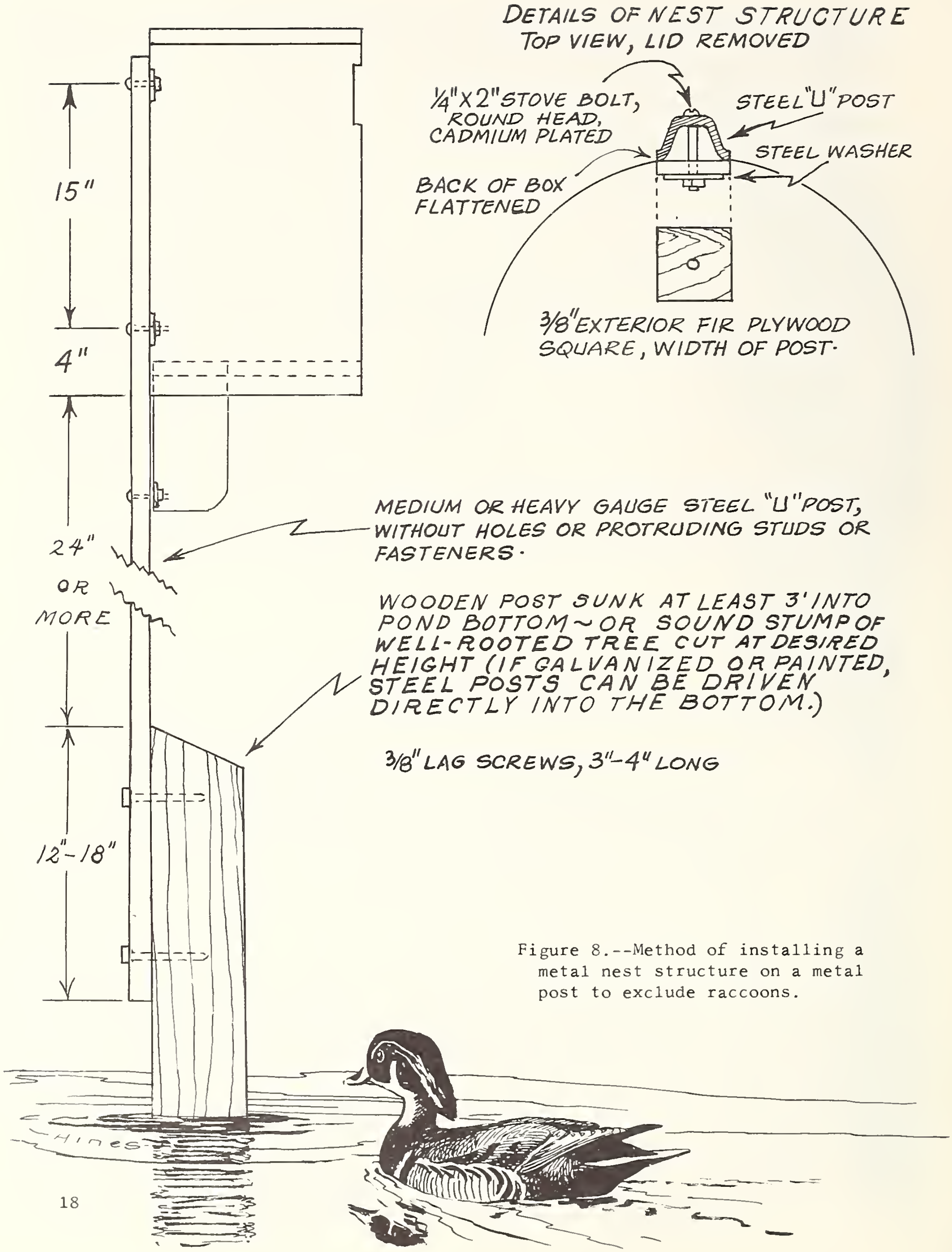

Figure 8.--Method of installing a metal nest structure on a metal post to exclude raccoons.

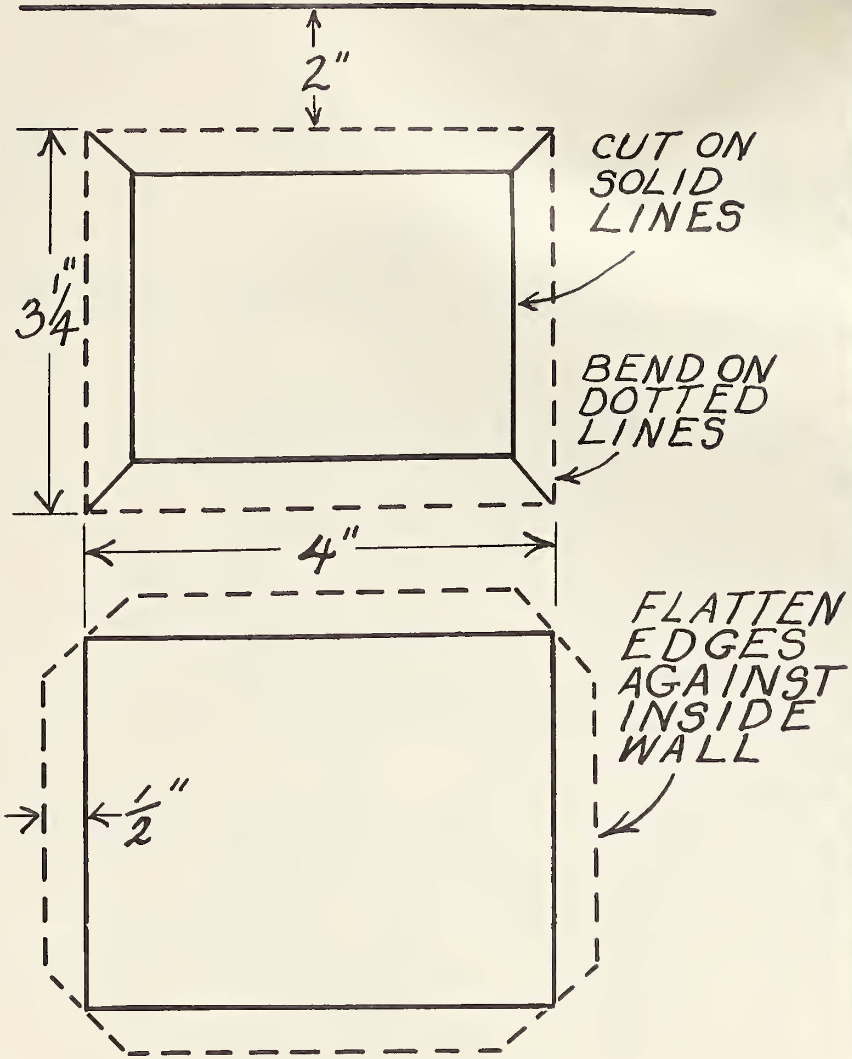

Figure 9.--An easily made entrance suitable for metal nest structures that are made raccoon-proof by the way they are supported.

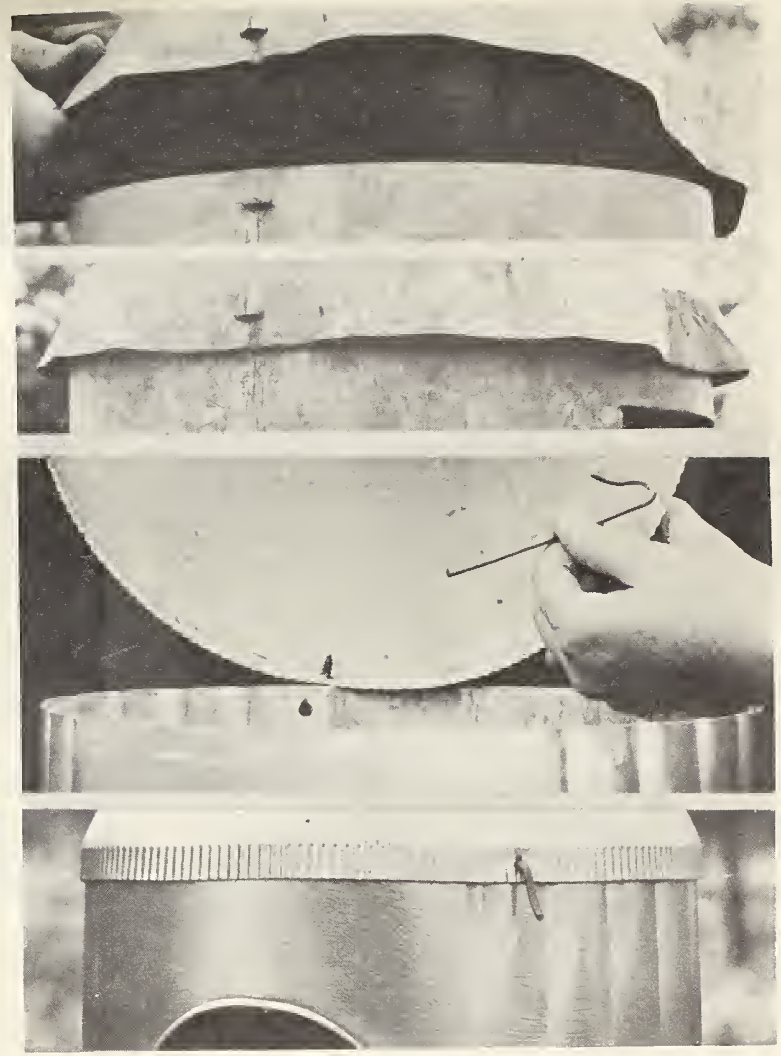

Figure 10. Two simple methods of attaching the roof of a metal nest structure. The roof is easily fastened in place or removed.

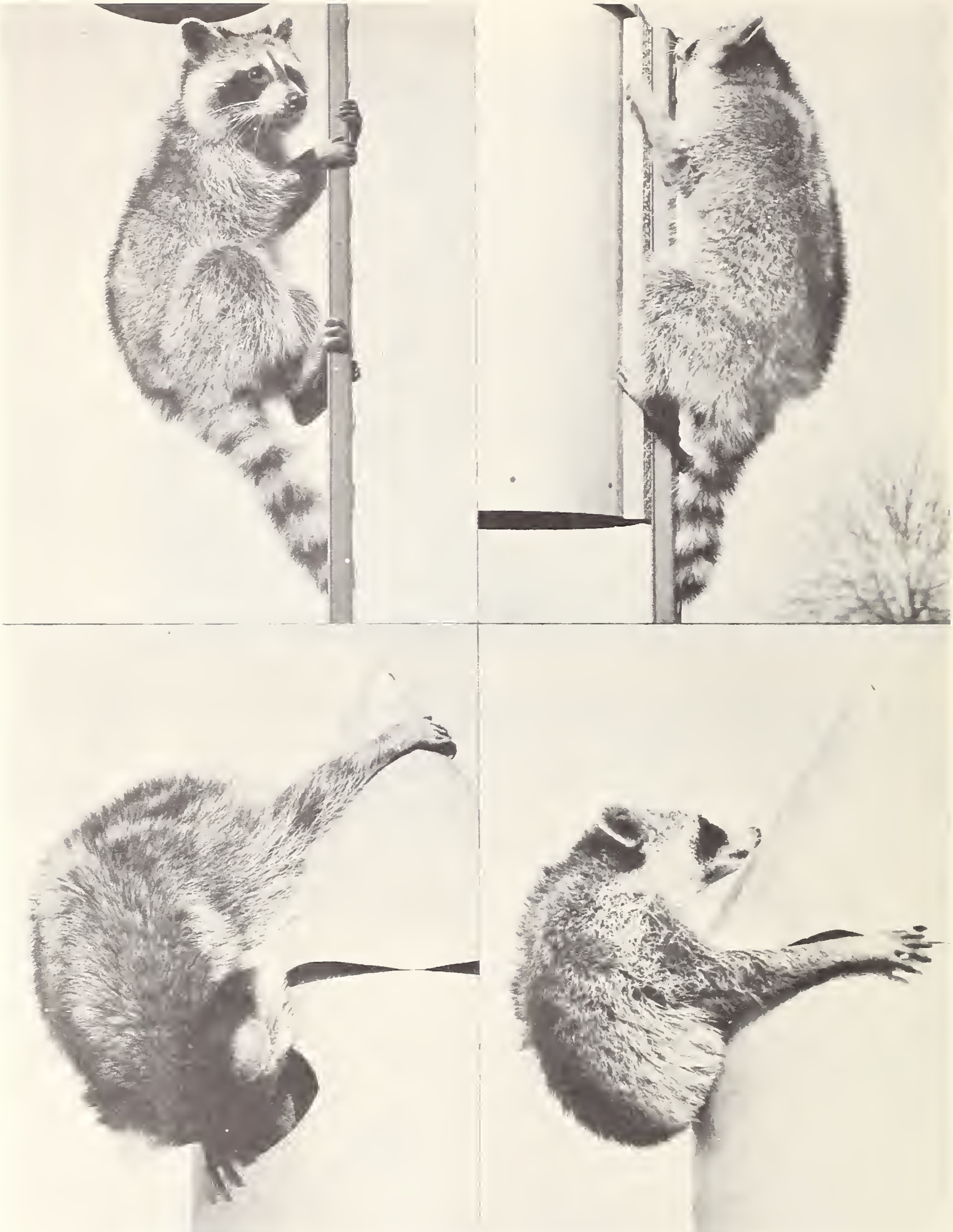

Figure 11.--A small, adult raccoon going up a metal post and wooden mounting board, then in and out of the 3- by 4-inch oval entrance of a metal nest box with conical roof. Without the board, which is unnecessary, he could not have climbed onto the box or reached the entrance.